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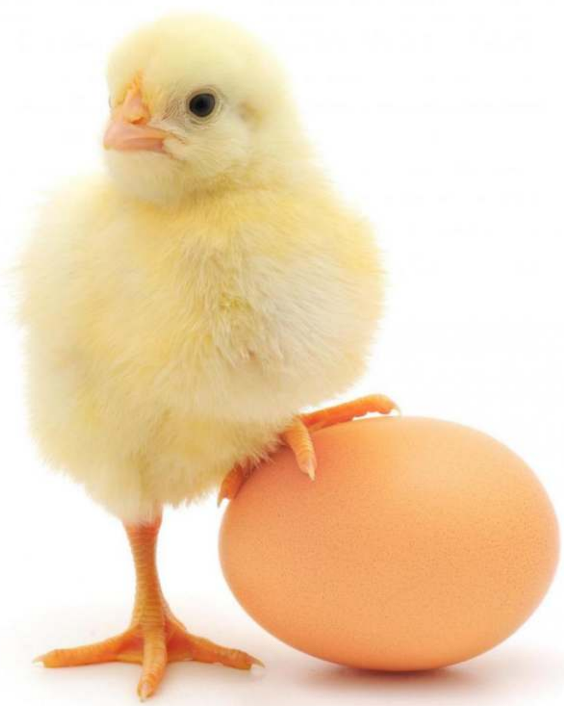

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Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorijps@gmail.com

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Research Article
Effects of Replacing Soybean Meal with Fermented Leaves and Seeds of the Rubber Tree (*Hevea brasiliensis*) on the Production Performance and Carcass Cholesterol Levels of Pitalah Ducks

[1]Erman Syahruddin, [2]R. Herawaty and [1]Azhar

[1]Department of Animal Production, Faculty of Animal Sciences, Andalas University, Limau Manis Campus, 25 163 Padang, Indonesia
[2]Department of Animal Nutrition, Faculty of Animal Sciences, Andalas University, Limau Manis Campus, 25 163 Padang, Indonesia

Abstract
Objective: This study aimed to determine the production performance and cholesterol content of Pitalah ducks fed a diet in which soybean meal had been replaced with rubber tree leaves and seeds fermented with the fungus *Trichoderma spiralis*. **Methodology:** A 12 week field trial was performed using 480, 1 day old Pitalah ducklings that were maintained in colonies in wire cages. Each unit was equipped with a feed enclosure, water and an incandescent light source. This randomized study was performed with 6 treatments, 4 replicates and 20 ducklings per box. The data were analyzed by ANOVA and differences among treatment groups were analyzed with Duncan's multiple range test. The treatments included a control diet and diets in which a percentage of the soybean meal (20, 40, 60, 80 and 100%) was replaced with fermented leaves and seeds of the rubber tree (FLSRT). The variables measured were feed consumption, body weight gain, feed conversion, carcass percentage, income over feed cost and carcass cholesterol content. **Results:** Broiler production factors, such as feed intake, body weight gain, feed conversion, carcass percentage, income over feed cost and carcass cholesterol content, were not markedly affected by the inclusion of up to 80% FLSRT in livestock rations. **Conclusion:** Up to 80% of the soybean meal in Pitalah duck rations can be replaced with FLSRT.

Key words: Rubber tree leaves and seeds, fermentation, conversion, income over feed cost, cholesterol

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Corresponding Author: Erman Syahruddin, Department of Animal Production, Faculty of Animal Sciences, Andalas University, Limau Manis Campus, 25 163 Padang, Indonesia

Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

The time it takes livestock to develop must be balanced with their nutritional needs, especially regarding protein sources, in the production of meat of sufficient quality. Ducks raised as livestock represent an alternative meat source to meet local dietary needs and are an important source of animal protein in Indonesia. Many people raise domesticated ducks because they grow rapidly, do not require a large area for upkeep and have a short maintenance time. However, heavy ducks tend to be fatty and have high cholesterol levels[1]. For most people, this high fat content impacts their decision to consume duck meat.

Major obstacles in the poultry industry, especially that in Indonesia, include the limited availability and relatively high cost of imported feed ingredients. According to the Directorate General of Animal Husbandry[2], imports of feed ingredients in 2014 reached 988.5 thousand tons of corn, 1.77947 million tons of soybeans and 226,900 t of meat and bone meal. Imported feed tends to be expensive and Indonesia has natural resources with potential for use as livestock feed. The livestock industry needs to develop continuously in available sources of poultry feed that do not compete with human needs. A potential source of raw materials for feed is the leaves and seeds of rubber trees (*Hevea brasiliensis*).

In Indonesia, leaves and seeds of the rubber tree are potentially useful byproducts as only a small portion of the seeds are used. Each tree is expected to yield 5,000 grains of seed per year[3, 4]. According to Syahruddin and Rita[5], rubber tree leaves contain 14.60% crude protein, 8.98% crude lipids, 17.81% crude fiber and 963 ppm hydrogen cyanide (HCN). Wizna *et al.*[6] stated that rubber tree seeds contain 19.20% crude protein, 47.2% crude lipids, 6.00% crude fiber and 573.72 ppm HCN. Their use in poultry rations is limited (5%) because of the high HCN content and bitter taste[7-9].

Processing using fermentation technology is one way to improve the nutritional value of leaves and seeds of the rubber tree. HCN and crude fiber content in the leaves and seeds of the rubber tree can be reduced by soaking and boiling. Leaves and seeds of the rubber tree have previously been fermented by Syahruddin and Rita[10] using the mold *Neurospora sitophila*, the fermented leaves and seeds of the rubber tree (FLSRT) were shown to be effective at replacing 80% of the soybean meal protein in a village's chicken feed.

Wiseman[11] suggested that the fungus *Trichoderma harzianum* produces an enzyme that can break down cellulose more completely than those in other fungi. Fati[12] studied rice bran fermented with *T. harzianum* and reported an increased crude protein content from 8.74-14.66% and a decreased crude fiber content from 18.90-12.81%.

Fermentation with *Trichoderma spiralis* has been suggested to improve crude fiber content in the leaves and seeds of rubber trees, to reduce the levels of abdominal fat in broiler chickens and to improve their carcass quality. The results of a study by Syahruddin and Rita[10] suggested that in broiler chickens, as the crude fiber content in the feed increases, the abdominal fat and cholesterol contents in the carcasses decrease. These effects occur because the fiber from the food can bind bile acids in the digestive tract, causing the bile acids to be excreted in the feces. This prevents the bile acids from breaking down fat and therefore reduces fat absorption[13,14]. Research by Wizna *et al.*[6] indicated that rubber seeds fermented with *Rhizopus oligosporus* can be used at up to 16% of feed for broiler chickens. In the present study, experiments were conducted to determine the effect of replacing up to 100% of soybean meal protein with FLSRT in Pitalah duck rations.

MATERIALS AND METHODS

Experiments were conducted to determine the effect of replacing up to 100% of soybean meal protein with FLSRT in Pitalah duck rations. The study lasted for 12 weeks and was conducted at the UPT Faculty of Animal Husbandry, Universitas Andalas Padang Limau Manis.

The process of leaves making and fermented leaves and seeds of the rubber tree is shown in Fig. 1.

Inoculation with *Trichoderma harzianum* as much as 9% of the substrate (2 cm thickness, pH 5.5) incubate for 3 days at temperature 30°C.

Research materials: In this experiment 480, 1 day old Pitalah ducklings were used and housed in cages. Research was conducted to test the addition of FLSRT to the rations. All experimental diets were prepared with equivalent amounts of protein and energy.

The treatments were as follows:

- R_0: 0% FLSRT (control diet without replacement of soybean meal)
- R_1: 20% of soybean meal replaced with FLSRT
- R_2: 40% of soybean meal replaced with FLSRT
- R_3: 60% of soybean meal replaced with FLSRT
- R_4: 80% of soybean meal replaced with FLSRT
- R_5: 100% of soybean meal replaced with FLSRT

The compositions of the different rations fed to ducks are provided in Table 1, the nutrient and metabolic energy contents are presented in Table 2.

Table 1: Composition of rations

	Experimental treatments					
Ingredients (%)	R_0	R_1	R_2	R_3	R_4	R_5
Corn	50.0	49.13	48.26	47.39	46.52	45.65
Soybean meal	20.0	16.00	12.00	8.00	4.00	0.00
FLSRT	0.0	5.87	11.74	17.61	23.48	29.35
Fine rice bran	15.5	14.50	13.50	12.50	11.50	10.50
Fish meal	13.5	13.50	13.50	13.50	13.50	13.50
Bone meal	0.5	0.50	0.50	0.50	0.50	0.50
Top mix	0.5	0.50	0.50	0.50	0.50	0.50
Total	100.0	100.00	100.00	100.00	100.00	100.00

Table 2: Nutritional and metabolic energy contents of the experimental rations

Components	R_0	R_1	R_2	R_3	R_4	R_5
Crude protein (%)	21.68	21.59	21.49	21.40	21.31	21.21
Fat (%)	3.91	3.90	3.89	3.88	3.87	3.86
Crude fiber (%)	4.78	5.17	5.56	5.95	6.34	6.73
Ca (%)	1.23	1.21	1.29	1.22	1.20	1.18
P total (%)	0.68	0.69	0.70	0.71	0.72	0.73
ME (kcal kg^{-1})	2942.80	2940.30	2937.80	2935.30	2932.80	2930.30
Methionine	0.296	0.295	0.293	0.291	0.290	0.289
Lysine (%)	1.11	1.053	0.99	0.93	0.87	0.82

Source: Proximate Analysis of Non Ruminant laboratory, Faculty of Animal Science Andalas University 2017

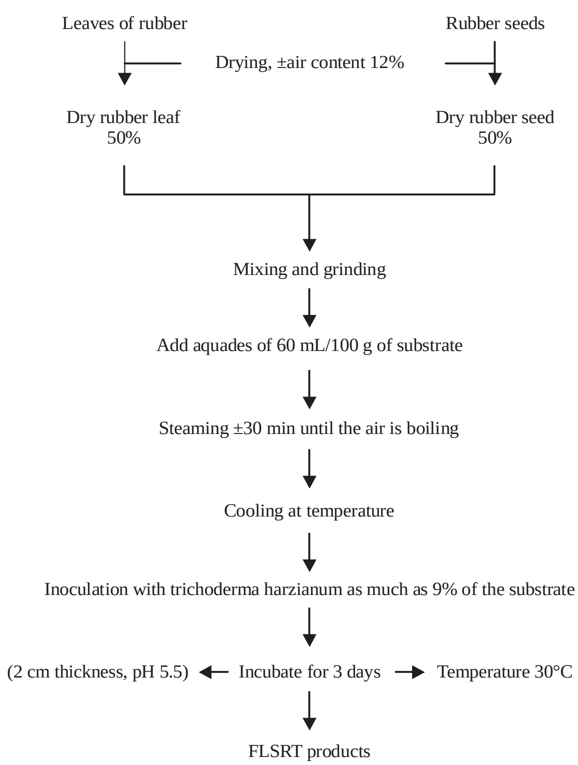

Fig. 1: Process of leaves making and fermented leaves and seeds of the rubber tree

Experimental design: Duck feeding experiments were conducted in a completely randomized design with 6 treatments and 4 replicates. The parameters measured were growth, feed intake, body weight gain, feed conversion, carcass percentage, cholesterol levels and income over feed cost (IOFC, gross profit):

$$\text{Carcass (\%)} = \frac{\text{Carcass weight}}{\text{Live duck weight}} \times 100$$

Cholesterol level was determined using the method of Liebermann Burchard color reaction as described by Kleiner and Dotti[15]:

$$\begin{array}{c}\text{Income over feed cost} \\ \text{(IOFC, gross profit)}\end{array} = \begin{array}{c}\text{(Final body weight×Sale price/kg)-} \\ \text{(Total feed intake×Feed price)}\end{array}$$

Statistical analysis: All data in this completely randomized study were analyzed by one-way analysis of variance (ANOVA) as specified by Steel and Torrie[16]. The differences among treatments were analyzed with Duncan's multiple range test (DMRT) and p<0.01 indicated statistical significance.

RESULTS AND DISCUSSION

Effect of experimental rations on feed consumption, body weight and feed conversion in pitalah ducks: The average feed consumption, body weight gain and feed conversion in Pitalah ducks fed rations containing FLSRT as a substitute for

Table 3: Mean feed consumption, body weight gain and feed conversion in Pitalah ducks during the study

Treatments	Feed consumption(g/head)	Body weight gain(g/head)	Feed conversion ratio
R_0	9378.92	1966.23^a	4.77
R_1	9404.28	1975.69^a	4.76
R_2	9371.59	1956.49^a	4.79
R_3	9381.12	1958.48^a	4.79
R_4	9303.46	1938.22^a	4.80
R_5	9072.25	1851.48^b	4.90
Average	9317.23	1941.09	4.80

Different letters in columns indicate significant differences (p<0.01) among treatments, SE = 0.97

soybean meal protein are presented in Table 3. Feed intake ranged from 9072.25-9404.28 g/head, body weight gain ranged from 1851.48-1975.69 g/head and feed conversion values ranged from 4.76-4.90. Data analysis indicated that the replacement of soybean meal protein with FLSRT in duck rations had no significant effect (p>0.05) on feed intake or feed conversion but significantly increased body weight (p<0.05).

The ducks consumed high levels of the FLSRT-substituted rations even when it contained 29.35% rather than 100% soybean meal protein. Soybean replacement did not affect feed consumption by Pitalah ducks during the study, likely because the FLSRT underwent a substantial change in quality and became more palatable after fermentation. According to Wahju[17], palatability determines the quantity of food consumed. FLSRT production with the fungus *T. spiralis* over 8 days at 30°C increases the nutritional value of the leaves and seeds because enzymes produced by *T. spiralis* break down complex components into simpler substances that are easier to digest. In addition, fungi can produce preferred aromas and flavors[18] that make food more palatable. No differences were observed among the treatments regarding energy and protein intake because the ducks adjusted their consumption based on the energy and protein contents of the rations[17].

An increase in the amount of FLSRT substituted for soybean meal protein in the diet was correlated with a significantly greater decrease in body weight gain in ducks reared to 4 weeks of age (p<0.05) (Table 3). The DMRT results showed no significant differences (p>0.05) among the FLSRT treatments R_0, R_1, R_2, R_3 and R_4, but the effects of these treatments were significantly (p<0.05) greater than those of treatment R_5.

No significant (p>0.05) effect of treatment R_0, R_1, R_2, R_3 or R_4 on weight gain was observed, each treatment resulted in the same weight gain at the end of the study. This finding indicates that fermentation improved the digestibility of the FLSRT and that protein from FLSRT can be used as a substitute for soybean meal protein in duck rations. Growth rate is partially determined by the amount of nitrogen retained from feed. When proteins are highly digestible, nitrogen retention is high[17].

The digestibility of crude protein and nitrogen retention from the FLSRT used in the rations were 76.77 and 74.19%, respectively. The essential amino acids methionine and lysine were present at 0.365 and 1.33%, respectively. The low weight gain in the R_5 group (29.35% FLSRT) compared with the other groups could have resulted from increased nucleic acid content in the rations[19]. High levels of nucleic acids affect the need for selenium (Se) in the body because some single-cell protein sources are low in Se[20], consequently, this feed could have contributed to Se deficiency. This would be consistent with the research conducted by Succi *et al.*[21], who found that substitution of soybean meal with yeast protein without Se supplementation produced very slow growth in chickens by 21 days of age.

In addition, the low body weight in the R_5 group could have been due to the increase in the crude fiber content of the feed beyond 5.92%. The optimal results reported by Soeharsono[22] showed that crude fiber in feed for 4 weeks old ducks should not exceed 5.5%. Feed conversion values based on feed usage indicate that the lower the feed conversion rate, the more efficiently the rations are used by ducks. In this study, feed conversion in Pitalah ducks ranged from 4.76-4.90, with no statistically significant differences (p>0.05). The feed intake and weight gain were similar among the groups and therefore, feed conversion, which is the ratio of feed consumed to weight gain, was the same. Although body weight gain was significantly (p<0.05) lower in the R_5 group, feed consumption also decreased because of the higher crude fiber content, which slowed the rate of food processing in the digestive tract. In addition, the high volume of the FLSRT reduced consumption because it decreases the space available for additional food.

Treatment effects on carcass percentages, cholesterol levels and IOFC in Pitalah ducks: The mean carcass percentage, cholesterol level and IOFC in Pitalah ducks fed rations containing FLSRT as a substitute for soybean meal protein are shown in Table 4. There were no significant treatment effects (p>0.05) on carcass percentage, which is the ratio of carcass weight to live weight multiplied by 100[23], likely because ducks with a higher body weight have a high carcass weight[17].

Table 4: Effects of treatments on carcass percentage, cholesterol level and income over feed costs in Pitalah ducks

Treatment	Carcass (%)	Carcass cholesterol level carcass (mg dL^{-1})	Income over feed cost (Rp)
R_0	65.76	92.21	282.60
R_1	67.99	88.12	370.33
R_2	67.21	85.73	458.06
R_3	67.56	85.43	545.79
R_4	68.74	84.98	633.52
R_5	65.93	83.84	510.93
Average	66.865	86.72	466.87

The carcass percentages obtained in this study are higher than those reported by Kompiang *et al.*[19], which ranged from 64.7-66.2%. However, they are within the expected range for ducks. The percentages for prepared beef carcasses are between 65 and 75%[23].

The amount of gross revenue was calculated to determine the benefits of the work done. Gross revenue represents the difference between sales revenue and the cost of rations, Pitalah ducks and ducklings.

Table 4 shows that increasing the percentage of FLSRT in the diet lowered the carcass cholesterol levels but this effect was not significant (p>0.05).

The lower cholesterol content in the R_5 group was correlated with greater FLSRT consumption, suggesting that increasing the use of FLSRT can lower the carcass cholesterol content. Tanaka *et al.*[24] found that the use of fermentation products as feed ingredients suppressed the activity of 3-hydroxy-3-methylglutaryl Co-A reductase, which synthesizes cholesterol in the liver and plays a key role in the formation of mevalonate during cholesterol synthesis, inhibiting this essential step reduces the cholesterol content in duck carcasses[25].

The carcass cholesterol levels recorded in this study were lower than those reported by Ariestya[26], who observed carcass cholesterol levels ranging from 97.44-100.04 mg dL^{-1} when fermented wheat was substituted. The present results were higher than those reported by Syahruddin[1], who found carcass cholesterol levels ranging from 41.12-53.91 mg dL^{-1} after the use of fermented Noni leaves.

Table 4 shows that increasing the use of FLSRT in rations increases profits, FLSRT is cheaper than soybean meal, leading to reduced feed and production costs. However, replacing 100% of the soybean meal resulted in a decline in profits because of the reductions in live weight and carcass weight. The substitution of upto 75% of soybean meal protein with FLSRT in feed can provide higher returns than the use of rations without FLSRT: Rp 370.33 (R_1), Rp 458.06 (R_2), Rp 545.79 (R_3) and USD 633.52 (R_4).

Because live weights were lower in the R_5 treatment group due to the high feed conversion rate, the IOFC associated with 100% replacement of soybean meal protein with FLSRT was lower than that for other treatments. The final results from the present study suggest an increase in profits with the use of FLSRT, which is consistent with the opinion of Rasyaf[27], because variation in the price of food rations is attributable to the protein source.

CONCLUSION

Pitalah duck production performance, which primarily depends on feed intake, body weight gain, feed conversion, carcass percentage, IOFC and carcass cholesterol levels, is not greatly affected by replacing up to 80% of soybean meal with FLSRT in livestock rations. Therefore, up to 80% of the soybean meal protein in feed for Pitalah ducks can be replaced with the discarded leaves and seeds of the rubber tree after fermentation by the fungus *T. spiralis*.

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